IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF: Ki-Ho Baik et al.	§ GROUP ART UNIT: 1756
SERIAL NO.: 10/817,140	§
	§ EXAMINER: B.L. Raymond
FILED: April 2, 2004	§
FOR: METHOD OF IMPROVING THE UNIFORMITY OF A PATTERNED RESIST ON A PHOTOMASK	§ Attorney Docket No.: AM-8893

Date: February 25, 2008

DECLARATION OF PRIOR INVENTION UNDER 37 CFR § 1.131

Mail Stop Petition
Hon. Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This Declaration is to be combined with the Declaration Under 37 CFR § 1.131 which was filed in response accompanies Response "B", which is in response to the Office Action mailed July 25, 2007.

Ki-Ho Baik, Mark A. Mueller, Stephen Osborne, Robert Dean, and Homer Lem are joint inventors of the invention claimed in U.S. Patent Application Serial No. 10/817,140. I, Homer Lem, declare that said invention was conceived and reduced to practice by the above-named inventors prior to January 6, 2004, which is the filing date of U.S. Patent Application Serial No. 10/752,885, which was published on December 30, 2004, as U.S. Publication No. 2004/0266113.

CERTIFICATE OF MAILING UNDER 37 CFR 1.10

I hereby certify that this paper and any documents said to accompany this paper are being deposited with the U.S. Postal Service on the date shown below with sufficient postage as U.S. EXPRESS MAIL NO. EB 450583747 US in an envelope addressed to : Mail Stop AF, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Date: February 25, 2008

Shirley L. Church, Reg. No.31,858

In support of our Declaration, attached is a copy of the Invention Alert which preceded the present patent application. This Invention Alert was prepared by us and sent electronically to the docketing department of Applied Materials, Inc. on 11/21/2003. Subsequently, the Invention Alert was returned to us for signature, and signatures were obtained between December 17 and December 18, 2003. The signatures were witnessed on December 18, 2003, a Docket No. of 8893 was assigned, and the Invention Alert was scheduled to be sent out to an attorney for preparation of a patent application on that date.

Portions of the Invention Alert which pertain to conclusory dates of invention have been dedacted to protect the rights of the inventors.

We, the undersigned, each declare that all statements made herein are of his own knowledge true, and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both under Sec. 1001 of Title 18 of the United States Code, and that such willful false statements and the like may jeopardize the validity of the application or any patent issued thereon.

1) _____ _____
Ki-Ho Baik, Co-inventor

2) _____ _____
Mark A. Mueller, Co-inventor

3) _____ _____
Stephen Osborne, Co-inventor

4) _____ _____
Robert Dean, Co-inventor

5) Jan. 22, 2008 Homer Lem
Homer Lem, Co-inventor

ENTERED

ALERT NO: 8893

INVENTION ALERT FORM

Date: 11/21/2003

TO: Gaile Bailey M/S 2061/Extension 32724

CIRCLE ONLY ONE FROM TOP ROW(REQUIRED FIELD):-

MASK/ETEC

EPI/ SUBSTRATE 3365	WCVD / 2492	CMP 1399	METAL 0881	CPS 0676	CORE ENG 0793	COPPER 2492	AKT	ATD 1301	APD	FBT 3037	HDPCVD 0281	CONDUCTIVE 1077	MDR	ETE
OXD 3365	Ti/TiN 2492		SILICON 0916	SMO/ GAS 1649	EPS 2590	ALUMINUM 2492	EBT		CDSEM	MDR/ DSI 3047	BCVD 0166	PARAMETRIC 1755	MMCS/ APC	RT
LPCVD 3365	ALD		DIELECTRIC/ RIE 0521	SMO/ PUMP 1651	DT 2492	LINER/ BARRIER 2492			WF		LOW K 2445	ORION/CON 2471	MMCS/ Modular Controller 3413	
GCM 3365			DIELECTRIC/ ICP 0521	EPIC 2442		Copper Plating(ECP) 2492			DRSEM		ELK 2445	ORION/PAR 2471	SmartSys	
WET CLEAN 3365			CONDUCTOR 0894	SCALPEL					GEMI				PDC-DSI 3396	
PMD 3365			CHAMBER TECH 0894	CONSILIUM 2199					ICT					
OTHER 3365			CORE TECH 1245	ECOM					EBI					
						COPPER					Dual Dam			

1. Title of Invention (please print clearly): **Vacuum Treatment for Improvement of Uniformity of Patterned Resist on a Photomask and Wafer**

2. Inventors-Names only-(please print clearly and provide complete information at Section 9.)

Ki-Ho Baik, Mark Mueller, Steve Osborne, Robert Dean, Homer Lem

COPY

Please use separate attachments for any answers that don't fit on the form, especially for questions 3-8. If the answer to a question is "NONE", please write "NONE" rather than leaving the answer blank.

3. Earliest dates and model names of all Applied products incorporating the invention which have been offered for sale or are expected to be offered for sale:

Mebes eXara, electron beam photomask writer,

RSB, electron beam photomask writer,

Tetra1, photomask etcher,

Tetra2, photomask etcher,

4. If the invention has been demonstrated or described to persons other than Applied employees, for each disclosure please provide the earliest date, name of company, a brief description of what was disclosed and the purpose of the disclosure. Attach a copy of any related non-disclosure agreements:

NOT described outside Applied Materials, not yet disclosed.

5. If future disclosures like those in Question #4 are expected to occur within the next 12 months, please provide the anticipated date, type of information to be disclosed, and purpose of the disclosure:

NONE [ ]

This invention would be most useful for ETEC to meet its technical specifications and commitments at IBM, where an RSB is being evaluated and compared to a competing product. Therefore it would be in Applied Materials' business interests to disclose this invention to IBM as soon as possible, in order to improve the ETEC-RSB product performance and gain a competitive advantage.

Preliminary data shows an improvement in resist local CD uniformity as a result of vacuum treatment. CD uniformity improvement in resist is between zero and 1 nm 3sigma, which is significant.

This invention is expected to be of significant interest to the photomask user community. Thus publication, after patent filing protection of IP, would serve Applied Materials' interests in advertising lithographic patterning capabilities.

6. Describe any other known designs or processes, whether actually implemented or merely proposed in a publication, which could be considered similar to your invention or which constitute the state-of-the-art improved upon by your invention: If described in a publication, attach a copy of same or provide a citation.

No known publications describe anything similar to this invention.

A broad search on the US Patent Office website (USPTO.com) scanning for the phrase "resist AND vacuum AND (semiconductor OR lithography OR photomask)" in claims turned up no previous patent which has any similarity to the invention proposed here. There are no reported applications of vacuum processing which claim or report what we are listing below as a novel and non-obvious feature.

The state-of-the-art electron beam photomask processing sequence is summarized:

1. Photomask is coated with resist, post-~~exposure~~ application baked (PAB), and exposed (electron beam or

laser used for creating a pattern onto the photomask resist).

2. The photomask is post-exposure baked (PEB) and developed, which removes the unpatterned resist from the plate.

3. The photomask is then etched, whereby the resist pattern is transferred into an underlying chrome layer. Additional etching may be required for phase-shift masks (PSM).

7. List each feature of the invention which you consider novel and non-obvious. Describe the advantages of each novel feature in comparison with the state-of-the-art approaches which are most similar to your invention:

Novel and Non-Obvious Features:

1) Use of a post-develop, pre-etch vacuum processing step to reduce variation in critical dimensions on photomasks. The advantage of such a processing step is of enormous benefit to photomask manufacturers. By reducing variation in critical dimensions, the quality of the photomask is improved.

   State of the art: No specific vacuum treatment of photomask. The photomask is simply developed, air exposed (and possibly measured in a CD-SEM to get resist CD information), and then the chrome is etched.

2) Use of vacuum to alter the composition and dimensions of resist features on a photomask. By applying a vacuum to a photomask (or wafer) for about 20 minutes, water vapor and solvent are desorbed by the surface of the resist. This may enable surface tension (or other mechanisms not yet studied in complete detail) to minimize roughness on the sidewall of a resist feature, which reduces line edge roughness (LER) and also reduces CD variation. Vacuum processing affects the mean CD by only a few nanometers.

   State of the art: One commonly applied means of altering resist dimensions on a photomask (or wafer) is the use of a "descum" oxygen plasma step. This basically burns away a fixed amount of resist, which unfortunately reduces the resist dimensions by at least 30nm, but also may also help to smoothen line edges. Descum treatment is not applicable to small feature lithography, since this step consumes a significant amount of lateral resist.

3) Application of vacuum treatment to reduce Line Edge Roughness (LER) on resist lines on a photomask (patterned by either electron beam or laser).

   State of the art: Descum (see #3 above).

4) Application of vacuum to a photomask plate in a photomask etching chamber in which chamber walls and dome are heated, allowing the resist on the photomask to warm to a temperature between 30 degrees C and 55 degrees C, which enables the desorption from the surface of the resist of water vapor, solvents, and materials absorbed onto the surface from the develop process step and other previous steps. In particular, the Applied Materials Tetra etching system is used for this vacuum treatment. Photomasks are placed into a chamber for 20 minutes of vacuum time, where the 55 degree chamber wall and 70 degree dome radiate heat onto the photomask plate. Longer times do not provide any improvement in desorption. The "curve" of resist change is observed to flatten out at 20 minutes.

5) Application of a vacuum treatment to a photomask (or wafer) after electron beam exposure (or laser or other methods of resist exposure) to reduce critical dimension variation.

Preliminary data from delayed removal of a photomask from the RSB electron beam writer has shown that CD uniformity may be slightly improved. A nine-hour delay time was utilized in this preliminary work. Delayed removal places the photomask in vacuum for a longer period, prior to air exposure and immediate Post-Exposure Bake. It is possible to perform this vacuum treatment in a Tetra (Applied Materials photomask etcher) chamber, where the vacuum treatment does not impact the RSB throughput. It is also possible to perform the vacuum treatment in other vacuum chambers.

6) **Generalization of #1 through 5 to include wafers and other substrates.** General application to wafers can improve the quality of lithography in the patterning of wafers. Specifically, this can be applied to all wafer lithographic processes where critical dimension control is required, for all wavelengths of light utilized in wafer lithography (G-line, i-line, KrF, ArF, 157) plus other methods used for patterning resist on wafers, such as e-beam, FIB, X-ray, and EUV. Line edge roughness is reduced, and critical dimension control is improved.

8. Describe the invention, preferably with reference to attached drawings:

The invention consists of an additional processing step in the standard "state of the art" sequence described above in Part 6. This is specifically a vacuum applied to the photomask between Step 2 and Step 3 (as noted above in Part 6). Proper timing of the vacuum allows for desorption of materials from the resist surface. Such desorption is found to slightly decrease the thickness of the resist layer. In addition, a slight shrinkage of pattern dimension is observed in the lateral (photomask plane) directions. Moreover, our data shows an improvement in Local CD Uniformity, in which crosses of a given fixed size are printed within a 1mm square, and then measured. Variations in local CD Uniformity can be attributed to a) various electron beam fluctuations during resist patterning and b) process-related line-edge roughness. The ETEC process has succeeded in drastically reducing the latter by creating a proprietary resist and fine-tuning all of the resist-related processing parameters. However, we believe at this time that vacuum processing is capable of further reduction in line-edge roughness, resulting in reduced Local CD Uniformity.

Two types of vacuum treatment are described above in the previous section. Vacuum treatment can be applied to a photomask immediately after exposure and before PEB (Post Exposure Bake). This enables acids within the resist to diffuse in such a way as to improve contrast and to reduce line edge roughness.

Another vacuum treatment is applied to the photo-mask after develop. In this second vacuum treatment, water vapor and solvents are desorbed from the surface of the patterned resist. In this case, the surface includes sidewalls and the top resist surface. By desorbing the volatile components, the resist loses material and that part of resist close to the surface is in tension. This surface tension may allow for the "pulling together" of the surface which may smooth out sidewall roughness. Since the tension does not apply to the bulk of the resist (deeper than within a few nanometers of the surface), lines and other features are not distorted.

ATTACH ADDITIONAL SHEETS TO DESCRIBE INVENTION AS NEEDED

Provide the following information for EACH inventor** REQUIRED FIELDS:

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Inventor

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Citizenship: _____

Home Address: _____

Manager _____ Title: _____

Div. Manager _____ Title:. _____

Product Group: _____ Dept #: _____

10. Signature, date and PRINTED name of each inventor plus two witnesses who have read and understood this Invention Alert form:

Inventors:

Printed Name	Date	Signature
MARK MUELLER	12/17/03	Mark Mueller
Robert Dean	12/17/03	
K. Ho BACIC	12/A/03	
Homer Lem	12/18/03	Homer Lem
Stephen Osborne	12/18/03	S. T. Osborne

Witness:

Printed Name	Date	Signature
DAMON M. COLE	12/18/03	Damon M. Cole
Allen R. Cook	12/18/03	Allen R. Cook

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